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UTILITY PATENT APPLICATION TRANSMITTAL
(new nonprovisional applications under 37 CFR 1.53(b))

Transmitted herewith for filing is the patent application of:

INVENTOR(S): Toru YAMADA

TITLE: FRAME DISPLAY METHOD AND APPARATUS USING SINGLE FIELD DATA

In connection with this application, the following are enclosed:

APPLICATION ELEMENTS:

XX Specification - 18 TOTAL PAGES

(preferred arrangement:)

-Descriptive Title of the Invention
-Cross Reference to Related Applications
-Statement Regard Fed sponsored R&D
-Reference to Microfiche Appendix
-Background of the Invention
-Brief Summary of the Invention
-Brief Description of the Drawings (if filed)
-Detailed Description
-Claim(s)
-Abstract of the Disclosure

XX Drawings - Total Sheets 5

XX Declaration and Power of Attorney - Total Sheets 2

XX Newly executed (original or copy)

____ Copy from a prior application (37 CFR 1.63(d))

(relates to continuation/divisional boxes completed) - NOTE: Box below

____ DELETION OF INVENTOR(S) - Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

____ Incorporation By Reference (useable if copy of prior application Declaration being submitted)

The entire disclosure of the prior application, from which a COPY of the oath or declaration is supplied as noted above, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

____ Microfiche Computer Program (Appendix)

____ Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)

____ Computer Readable Copy
____ Paper Copy (identical to computer copy)
____ Statement verifying identify of above copies

ACCOMPANYING APPLICATION PARTS

XX Assignment Papers (cover sheet & document(s))
____ 37 CFR 3.73(b) Statement (when there is an assignee)
____ English Translation Document (if applicable)
XX Information Disclosure Statement/Form PTO-1449/Three (3) References
____ Preliminary Amendment
XX Return Receipt Postcard (MPEP 503)
____ Small Entity Statement(s)
____ Statement file in prior application, status still proper and desired.
XX Certified Copy of Priority Document(s) with Claim of Priority (if foreign priority is claimed).
XX OTHER: Check in the amount of $760.00

If a **CONTINUING APPLICATION**, **check appropriate box and supply the requisite information:**

__ Continuation __ Divisional __ Continuation-in-part (CIP) of prior application Serial No. __.

__ Amend the specification by inserting before the first line the following sentence: --This application is a __ continuation, __ divisional or __ continuation-in-part of application Serial No. __, filed __.--

CORRESPONDENCE ADDRESS:

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FEE CALCULATIONS: (Small entity fees indicated in parentheses.)

(1) For	(2) Number Filed	(3) Number Extra	(4) Rate	(5) Basic Fee $760 ($380)
Total Claims	7 - 20 =	0	x $18 (x $9)	
Independent Claims	3 - 3 =	0	x $78 (x $39)	
Assignment Recording Fee per property			$40	$40.00
Surcharge Under 37 C.F.R. 1.16(e)			$130 ($65)	
			TOTAL FEE:	$800.00

METHOD OF PAYMENT:

A check in the amount of the above TOTAL FEE is attached. If payment is enclosed, this amount is believed to be correct; however, the Commissioner is hereby authorized to charge any deficiency or credit any overpayment to Deposit Account No. 19-0741.

Respectfully submitted,

for / Phillip J. Articola Reg. No. 38,819
David A. Blumenthal
Reg. No. 26,257

Date: June 4, 1999
Docket No.: 088941-0138

FRAME DISPLAY METHOD AND APPARATUS USING SINGLE FIELD DATA

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a technique for reproducing dynamic images from compression coded image data. In particular, the present invention relates to a method and apparatus for displaying picture frames using single field data contained in two-field image data, for example, in image data encoded by the MPEG-2 (Moving Picture Experts Group 2) standard.

Background Art

Scanning methods of dynamic images mainly consist of two types of methods, that is, sequential scanning and interlace scanning. In the sequential scanning method, data of all pixels in each frame are obtained at the same moment. In contrast, in the interlace scanning method, data of pixels in even-numbered and odd-numbered scanning lines in each frame are obtained at different moments. Compression of dynamic images according to the MPEG-2 (Moving Picture Experts Group 2) standard supports both the sequential scanning and the interlace scanning.

However, in the case where interlaced dynamic image data scanned by the MPEG-2 system is reproduced by a computer system, because the CRT display displays the interlace scanned dynamic images by sequential scanning, the dislocation of pictures in the two fields which form each frame deteriorates the quality of the dynamic image.

In order to prevent the deterioration of the quality of dynamic images in such a

case, various techniques have been proposed for transforming interlacedly scanned dynamic data to dynamic image data suitable for the sequentially scanning display. For example, in the line interpolation method, data of one field is copied to the other field in the same frame, and each line in the first field is displayed twice in the manner of the sequential scanning. In the linear interpolation method, averages of each of the neighboring lines are taken, and each line in one of the fields and the averaged line are alternatively displayed in the manner of sequential scanning. In another method, after the mobility of the image between the two fields is calculated, the linear interpolation method is applied when the mobility is large, and the line interpolation method is applied when the mobility is small.

However, both the line interpolation method and the linear interpolation method have the drawback that the definition of dynamic images is reduced and images become indistinct. Furthermore, the third method requires high calculation speed for calculating the mobility of the image, and has the drawback of burdening the computer system.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an apparatus and method in which it is possible to display with high quality, by the sequential scanning, the interlacedly scanned image data having two-field structure such as the MPEG-2 encoded image data.

In order to accomplish the above objective, the first aspect of the present invention is a method for displaying picture frames using single field data in interlaced encoded image data having a two-field structure, comprising the steps of: performing

inverse quantization of the interlaced encoded image data to obtain DCT (Discrete Cosine Transform) coefficients for each field block (for example, 8×8 pixels); selecting one of two fields forming each picture frame; adding zero values after the DCT coefficients of each field block in the selected field in order to obtain compensated DCT coefficients having a data length corresponding to one frame block (for example, 8×16 pixels); and performing inverse DCT of the compensated DCT coefficients to obtain pixel data for each frame block. Each of the picture frames can be displayed by combining the frame block data.

According to the first aspect, zero values are added after the DCT coefficients of each field block in the selected field in order to obtain compensated DCT coefficients having a data length corresponding to one frame block, and the inverse DCT of the compensated DCT coefficients to obtain pixel data for each frame. Therefore, it is possible to display picture frames which are clearer than those obtained by only twice enlarging of the single field image. Furthermore, there is no time-lag between the odd and even numbered scanning lines in the reproduced frames, and the dynamic images reproduced by the present invention are clear even if the motion of the images is fast.

The present method may further comprise the steps of determining frames for which to perform motion compensative prediction; and performing the motion compensative prediction of the pixel data corresponding to the frames to be compensated.

The second aspect of the present invention is a method for displaying picture frames using image using MPEG-2 (Moving Picture Experts Group 2) encoded image data obtained from NTSC (National Television System Committee) television signals, comprising the steps of: performing inverse quantization of the interlaced encoded

image data to obtain DCT (discrete cosine transform) coefficients for each field block; alternatively selecting one of odd and even fields forming each picture frame at 1/60 second intervals; adding zero values after the DCT coefficients of each field block in the selected field in order to obtain compensated DCT coefficients having a data size corresponding to one frame block; and performing inverse DCT of the compensated DCT coefficients to obtain pixel data for each frame block.

In this case, it is possible to display dynamic images having 60 picture frames in one second by sequential scanning, while reproducing dynamic images from MPEG-2 encoded image data having 30 interlaced frames (= 60 fields) in one second. Therefore, it is possible to display the NTSC dynamic image data with high quality.

This method may further comprise the steps of determining frames for which to perform motion compensative prediction; and performing the motion compensative prediction of the pixel data corresponding to the frames to be compensated. For example, in the case of operation for MPEG-2 encoded data, it is determined whether or not the reproduced frame is a P-picture or B-picture, and if the reproduced frame is not a P-picture or B-picture, but is an I-picture, which is not compressed by the motion compensative prediction, the frame data is displayed. However, when the reproduced frame is a P-picture or B-picture, the frame data is further decoded by the motion compensative prediction according to the MPEG-2 standards in order to reproduce the original frame data, and the decoded frame data is displayed.

The third aspect of the present invention is an apparatus for displaying picture frames using single field data in interlaced encoded image data having a two-field structure. This apparatus comprises: a compressed data buffer for loading and temporarily storing at least a part of the encoded image data; an inverse quantizer for obtaining DCT coefficients for each block from the encoded image data stored in the

compressed data buffer; a selecting device for selecting one of two fields forming each picture frame; a DCT coefficient addition device for adding zero values after the DCT coefficients of the selected field in order to obtain compensated DCT coefficients having a data length corresponding to one frame; and an inverse DCT processing device for performing inverse DCT of the compensated DCT coefficients to obtain pixel data in each frame.

According to this apparatus, it is possible to display the picture frames which are clearer than those obtained by only twice enlarging of the single field image as explained regarding the first aspect of the present invention. Furthermore, there is no time-lag between the odd and even numbered scanning lines in the reproduced picture frames, and the dynamic images are clear even if the motion of the images is fast.

This apparatus may further comprise a device for determining frames to perform motion compensative prediction and a device for performing the motion compensative prediction of the pixel data corresponding to the frames to be compensated.

Additionally, this apparatus may further comprise a storage device for storing the encoded image data to be displayed and a display device such as a CRT, for displaying the picture frames.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a frame display apparatus according to the first embodiment of the present invention.

Figure 2 is a schematic diagram illustrating image data having two-field structure.

Figure 3 is a schematic diagram illustrating addition of zero values after DCT

coefficients of a single field.

Figure 4 is a flowchart illustrating the frame display method according to the first embodiment of the present invention.

Figure 5 is a block diagram of the frame display apparatus according to the second embodiment of the present invention. .

Figure 6 is a flowchart illustrating the frame display method according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figures 1 to 6, the best modes of the frame display method and apparatus according to the present invention will be explained.

[First Embodiment]

Figure 1 is a block diagram illustrating the frame display apparatus of the first embodiment of the present invention. This apparatus comprises a storage device 1 for storing compressed image data, an MPEG decoder module 2 for decoding the compressed image data according to a program, and a display device 3 for displaying the decoded image data. In this embodiment, the storage device 1 stores encoded image data 11 having two-field structure, such as MPEG-2 encoded dynamic image data. The storage device 1 may be any conventional storage device such as a hard disk drive, a CD-ROM drive, a DVD-ROM drive, or a magnetic recorder. The MPEG decoder module 2 may be constructed in a computer system (not shown), and all devices thereof may be controlled by a CPU (not shown).

The MPEG decoder module 2 comprises a compressed data buffer 21 for

temporarily storing a part of the compressed image data 11, an inverse quantizer 22 for performing inverse quantization of the quantized image data stored in the data buffer 21, a field selector 23 for selecting one of two fields forming each picture frame, a DCT coefficient addition processing unit 24 for adding zero values after the DCT coefficients of each field block in the selected field in order to obtain compensated DCT coefficients having a data length corresponding to one frame block, a IDCT processing unit 25 for performing inverse DCT of the compensated DCT coefficients to obtain frame block data in each frame to be displayed, a motion forecasting processing unit 26 for performing the motion compensative prediction of the pixel data corresponding to the frames to be compensated, and a frame data buffer 27 for temporarily storing the decoded image data to be displayed. The display device 3 displays the decoded image data stored in the frame data buffer 27 in the manner of sequential scanning.

In the present embodiment, first, a part of the MPEG encoded image data 11 stored in the storage device 1 is read out and transmitted to the compressed data buffer 21. Because the encoded image data 11 has a two-field structure and has been quantized according to the MPEG-2 standard, the inverse quantizer 22 performs inverse quantization of the quantized image data stored in the data buffer 21, and reproduces DCT coefficients for each field block which consists of 8×8 pixels in this case. Each field block may consist of a different number of pixels, if necessary.

The dynamic image data which will be reproduced from the encoded image data 11 consists of a plurality of frames, and each of the frames consists of two fields, that is, odd field and even field, and each of the fields is divided into a plurality of field blocks consisting of 8×8 pixels, as shown in Figure 2. In the conventional frame display method using the sequential scanning, the pixel data decoded from the DCT

coefficients of the odd and even fields are arranged alternately as each of the scanning lines to form an image as shown in Figure 2. However, because there is a time-lag of 1/60 second between the odd and even fields, in the case where the motion of the images is large and the images are displayed by sequential scanning, the quality of images will be lowered and the images become indistinct.

In order to prevent such deterioration of the image quality, the present invention is characterized in reproducing each frame data using only one of the two field data forming each frame. First, one of the two field data is selected, and the DCT coefficients of each field block (for example, 8×8 pixels) in the selected field are calculated. Next, as shown in Figure 3, zero values are added after the calculated DCT coefficients of each field block to obtain compensated DCT coefficients having a data length corresponding to one frame block (for example, 8×16 pixels). If zero values are not added after the DCT coefficients, the image data which can be obtained by the IDCT (Inverse Discrete Cosine Transform) of the DCT coefficients will become half the size of the original image. By adding zero values after the DCT coefficient to double the size thereof, it becomes possible to reproduce image data having the same size as the original image by performing the IDCT. In general, the DCT coefficients have large values in the low frequency region thereof, and the values of the higher frequency region in the DCT coefficients will become zero values after performing the quantization of the DCT coefficients. Therefore, the doubling of the DCT coefficients by addition of zero values does not lead to an increase of the computation load.

By performing the IDCT of the compensated DCT coefficients, the pixels in the reproduced picture frame image are smoothly arranged between the neighboring scanning lines, it is therefore possible to display the images which are clearer than those

obtained by only twice enlarging of the single field image. Furthermore, there is no time-lag between the odd and even numbered scanning lines, and the dynamic images reproduced by the present method are clear even if the motion of the images is large or fast.

Figure 4 is a flowchart illustrating the steps of the frame display method by the first embodiment shown in Figure 1. In the step S1, a part of the compressed image data 11 is transmitted to the compressed data buffer 21. Since the compressed image data 11 has been quantized by the MPEG-2 standard, in the step S2, the inverse quantizer 22 performs the inverse quantization of the compressed image data 11 stored in the data buffer 21 to obtain the DCT coefficients. The DCT coefficients are the values obtained by performing the DCT of the pixel data contained in each field block, and the field block is, in this embodiment, a region consisting of 8×8 pixels in each of the two fields forming one frame. The number of the pixels in one field block may be changed, if necessary. The odd fields and the even fields respectively contain image data recorded at different times from each other.

In the step S3, the field selector 23 selects one of the two fields, and, in the step 4, as shown in Figure 3, the DCT coefficient addition processing unit 24 adds a necessary number of zero values after the DCT coefficients of each field block in the selected field in order to obtain the compensated DCT coefficients having a data length corresponding to one frame block size, which is 8×16 pixels in this case. By this operation, the high frequency region of the compensated DCT coefficients is occupied by the added zero values.

In the step S5, the IDCT processing unit 25 performs the IDCT of the compensated DCT coefficients to reproduce frame block data, which has 8×16 pixels in

this case. In the step S6, the obtained frame block data is transmitted to the frame data buffer 27, and in the step S7, the pointers are shifted to the next field block in the selected fields. In the step S8, it is determined whether or not all the field blocks in the selected field are finished, and if not, the steps S3-S7 are repeated. In the case of the completion of the operation for all blocks, the process goes to the step S9.

In the next step S10, it is determined whether or not the reproduced frame data stored in the frame data buffer 27 is compressed by the motion compensative prediction, that is, whether or not the reproduced frame is a P-picture or B-picture. A P-picture is a frame data compressed by the forward prediction, and a B-picture is a frame data compressed by the bidirectional prediction. If the reproduced frame is not a P-picture or a B-picture but is an I-picture which is not compressed by the motion compensative prediction, the process goes to the step S11, and the frame data is displayed on the display device 3. When the reproduced frame is the P-picture or B-picture, the process goes to the step S12, and the motion forecasting processing unit 26 decodes the frame data according to the motion compensative prediction in the MPEG-2 standards in order to reproduce the original frame data. The reproduced original frame data is stored again in the frame buffer 27, and the decoded frame data is displayed on the display device 3. Furthermore, the steps S1-S11 will be repeated until all the MPEG-2 encoded data is displayed.

Because the B-picture is encoded using the neighboring I-picture and/or P-picture, in the case where the I-pictures and the P-pictures are displayed according to the method of the present invention using the single field data, the quality of the B-pictures may be lowered. For such a case, it is also possible to apply the present invention to only the display of the B-pictures so that the degradation of the quality of the B-pictures can be reduced.

[Second embodiment]

The second embodiment of the present invention will be explained referring to Figures 5 and 6. This embodiment displays, on a display device such as a CRT, dynamic images having 60 frames per second by sequential scanning, from MPEG-2 encoded image data having 30 interlaced frames (= 60 fields) per second. This embodiment is suitable to the NTSC (National Television System Committee) system which uses, as a standard, the interlace scanning method in which 30 frames (60 fields) are reproduced per second.

Figure 5 is a block diagram of the hardware of the second embodiment, and in this embodiment, an odd field selector 23A and an even field selector 23B are provided in place of the field selector 23 in the first embodiment. The odd and even field selectors 23A and 23B respectively extract the odd and even field data from each of the frame data, in an alternative manner at intervals of 1/60 second. Other features are substantially the same as those of the first embodiment.

Figure 6 is a flowchart illustrating the steps of the frame display method by the second embodiment shown in Figure 5. In the step S101, the MPEG-2 encoded image data 11 stored in the storage device 1 is transmitted to the compressed data buffer 21. Since the compressed image data 11 has also been quantized by the MPEG-2 standard, in the step S102, the inverse quantizer 22 performs the inverse quantization of the compressed image data 11 stored in the data buffer 21 to obtain the DCT coefficients of each of all the field blocks in the two fields. In the second embodiment, each field block is a region consisting of 8×8 pixels in each of the two fields forming one frame, however, the number of the pixels in one field block may be changed if necessary.

In the step S103a, it is determined whether a timing variable T is "0" or "1", when the variable T is "0", the process goes to the step S103, and when the variable T is "1", the process goes to the step S203. According to the timing variable T, the odd and even field selectors 23A and 23B respectively extract the odd and even field data in an alternative manner at intervals of 1/60 second.

In the step S103, the odd field selector 23A extracts DCT coefficients (in this case, 8×8 pieces) corresponding to one field block in the odd field, and in the step 104, as shown in Figure 3, the DCT coefficient addition processing unit 24 adds a necessary number of zero values after the DCT coefficients of each field block in the odd field in order to obtain the compensated DCT coefficients having a data length (in this case, 8×16 pieces) corresponding to one frame block, which is 8×16 pixels in this case. By this operation, the high frequency region of the compensated DCT coefficients is occupied by the added zero values.

In the step S105, the IDCT processing unit 25 performs the IDCT of the compensated DCT coefficients to reproduce frame block, which has 8×16 pixels in this case. In the step S106, the obtained frame block is transmitted to the frame data buffer 27, and in the step S107, the pointer is shifted to the next field block in the same odd field. In the step S108, it is determined whether or not the operation of all the field blocks in the odd field are finished, and if not, the steps S103-S107 are repeated. In the case where the operation of all the field blocks is finished, the process goes to the step S108a, and the value "1" is input to the timing variable T. Furthermore, the process goes to the step S109, and the storage of one full frame data in the frame data buffer 27 is completed.

On the other hand, when the process goes to the step S203, the even field

selector 23B extracts DCT coefficients (in this case, 8×8 pieces) corresponding to one field block in the even field data, and in the step 204, the DCT coefficient addition processing unit 24 adds a necessary number of zero values after the DCT coefficients of each field block in the selected field in order to obtain the compensated DCT coefficients having a data length (in this case, 8×16 pieces) corresponding to one frame block size, which is 8×16 pixels in this case.

In the step S205, the IDCT processing unit 25 performs the IDCT of the compensated DCT coefficients to reproduce frame block data, which has 8×16 pixels in this case. In the step S206, the obtained frame block data is transmitted to the frame data buffer 27, and in the step S207, the pointer is shifted to the next field block in the same even field. In the step S208, it is determined whether or not the operation of all the field blocks in the even field are finished, and if not, the steps S203-S207 are repeated. In the case where the operation of all the field blocks is finished, the process goes to the step S208a, and the value "0" is input to the timing variable T. Furthermore, the process goes to the step S109, and the storage of one full frame data in the frame data buffer 27 is completed.

In the next step S110, it is determined whether or not the frame data stored in the frame data buffer 27 is compressed by the motion compensative prediction, that is, whether or not the reproduced frame is a P-picture or B-picture. A P-picture is a frame data compressed by the forward prediction, and a B-picture is a frame data compressed by the bidirectional prediction. If the reproduced frame is not a P-picture or B-picture but is an I-picture which is not compressed by the motion compensative prediction, the process goes to the step S111, and the frame data is displayed on the display device 3. When the reproduced frame is a P-picture or B-picture, the process goes to the step S112,

and the motion forecasting processing unit 26 decodes the frame data according to the motion compensative prediction in the MPEG-2 standards in order to reproduce the original frame data. The reproduced original frame data is stored again in the frame buffer 27, and the decoded frame data is displayed on the display device 3. In the step S113, it is determined whether or not all the MPEG-2 encoded data stored in the storage device 1 is displayed, and the steps S101-S111 will be repeated until the display of all the MPEG-2 encoded data is completed. Thus, this embodiment displays, on a display device 3, dynamic images having 60 frames per second by sequential scanning, while reproducing each picture frame from each field data in the MPEG-2 encoded image data having 30 interlaced frames (= 60 fields) per second, therefore, it is possible to display NTSC dynamic image data with high quality.

Similar to the first embodiment, also in the second embodiment, because the B-picture is encoded using the neighboring I-picture and/or P-picture, in the case where the I-pictures and the P-pictures are displayed according to the method of the present invention using the single field data, the quality of the B-pictures may be lowered. For such a case, it is also possible to apply the present invention to only the display of the B-pictures so that the degradation of the image quality of the B-pictures can be reduced.

Although two embodiments of the present invention were described above, the present invention is not limited to these embodiments. For example, any features in the two embodiments can be combined with each other, or, any conventional arts can be applied to these embodiements.

What is claimed is:

1. A method for displaying picture frames using single field data in interlaced encoded image data having a two-field structure, comprising the steps of:

performing inverse quantization of the interlaced encoded image data to obtain DCT (Discrete Cosine Transform) coefficients of each of field blocks;

selecting one of two fields forming each picture frame;

adding zero values after the DCT coefficients of each of field block in the selected field in order to obtain compensated DCT coefficients having a data size corresponding to one frame block; and

performing inverse DCT of the compensated DCT coefficients to obtain image data for each frame block.

2. The method for displaying picture frames according to claim 1, further comprising the step of:

determining frames for which to perform motion compensative prediction; and

performing the motion compensative prediction of the image data corresponding to the frames to be compensated.

3. A method for displaying picture frames using MPEG-2 (Moving Picture Experts Group 2) encoded image data obtained from NTSC (National Television System Committee) television signals, comprising the steps of:

performing inverse quantization of the interlaced encoded image data to obtain DCT (discrete cosine transform) coefficients for each field block;

alternatively selecting one of odd and even fields forming each picture frame at

1/60 second intervals;

adding zero values after the DCT coefficients of each field block in the selected field in order to obtain compensated DCT coefficients having a data size corresponding to one frame block; and

performing inverse DCT of the compensated DCT coefficients to obtain pixel data for each frame block.

4. The method for displaying picture frames according to claim 3, further comprising the step of:

determining frames for which to perform motion compensative prediction; and

performing the motion compensative prediction of the image data corresponding to the frames to be compensated.

5. An apparatus for displaying picture frames using single field data in interlaced encoded image data having a two-field structure, comprising:

a compressed data buffer for loading and temporarily storing at least a part of the encoded image data;

an inverse quantizer for obtaining DCT (Discrete Cosine Transform) coefficients for each field block from the encoded image data stored in the compressed data buffer;

a selecting device for selecting one of two fields forming each picture frame;

a DCT coefficient addition device for adding zero values after the DCT coefficients of each field block in the selected field in order to obtain compensated DCT coefficients having a data length corresponding to one frame block;

an inverse DCT processing device for performing inverse DCT of the

compensated DCT coefficients to obtain pixel data for each frame block; and

a frame data buffer for temporally storing the pixel data of the frame blocks.

6. The apparatus for displaying picture frames according to claim 5, further comprising a device for determining frames for which to perform motion compensative prediction, and a device for performing the motion compensative prediction of the pixel data corresponding to the frames to be compensated.

7. The apparatus for displaying picture frames according to claim 5, further comprising a storage device for storing the encoded image data to be displayed and a display device for displaying the pixel data.

ABSTRACT

The present invention relates to a method for displaying picture frames using single field data in interlaced encoded image data having a two-field structure. This method comprises the steps of: performing inverse quantization of the interlaced encoded image data to obtain DCT (Discrete Cosine Transform) coefficients of each of the field blocks; selecting one of two fields forming each picture frame; adding zero values after the DCT coefficients of each of field block in the selected field in order to obtain compensated DCT coefficients having a data size corresponding to one frame block; and performing inverse DCT of the compensated DCT coefficients to obtain image data for each frame block. According to this method, there is no time-lag between the odd and even numbered scanning lines in the reproduced picture frames, and the dynamic images are clear even if the motion of the images is fast.

FIG. 1

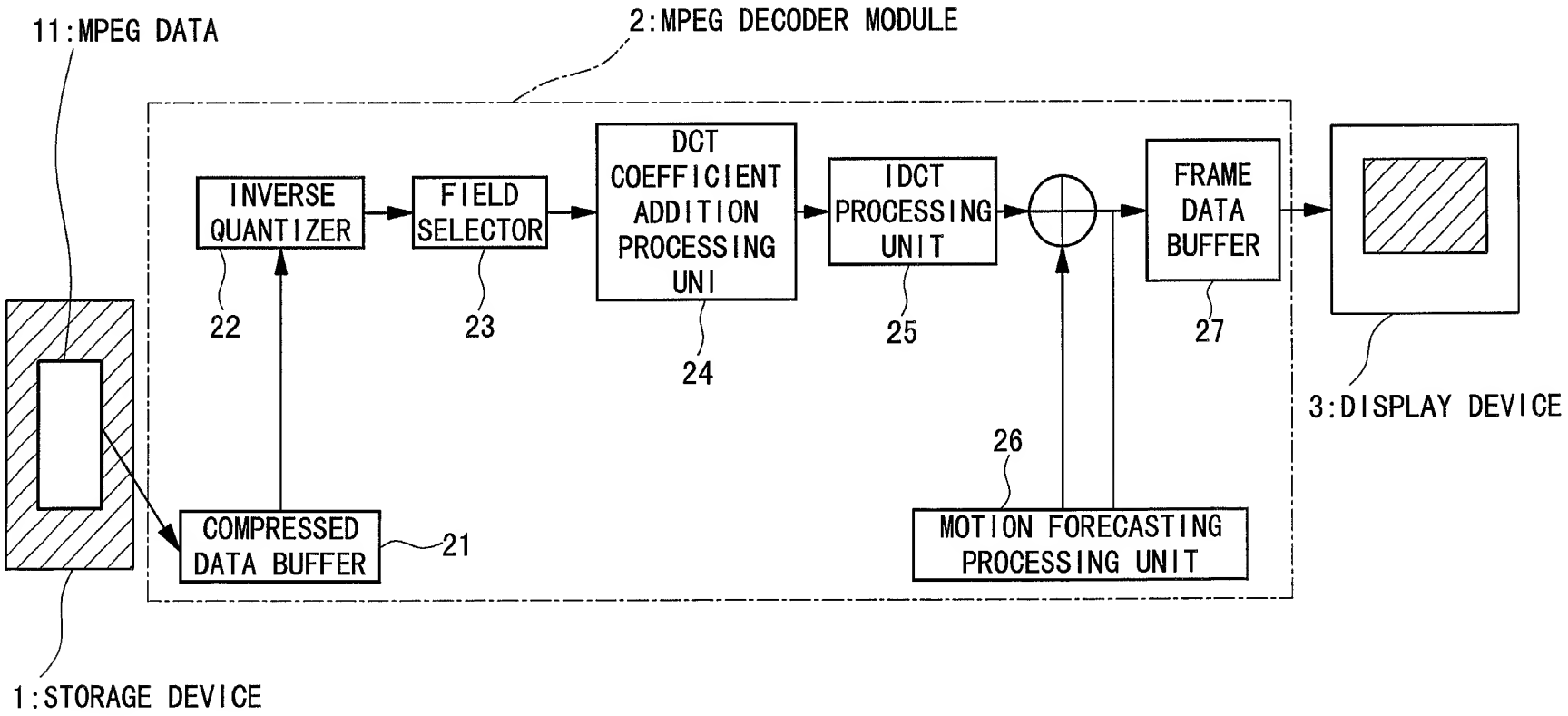

11:MPEG DATA
2:MPEG DECODER MODULE
INVERSE QUANTIZER
FIELD SELECTOR
DCT COEFFICIENT ADDITION PROCESSING UNI
IDCT PROCESSING UNIT
FRAME DATA BUFFER
22
23
24
25
27
3:DISPLAY DEVICE
26
COMPRESSED DATA BUFFER
21
MOTION FORECASTING PROCESSING UNIT
1:STORAGE DEVICE

FIG. 2

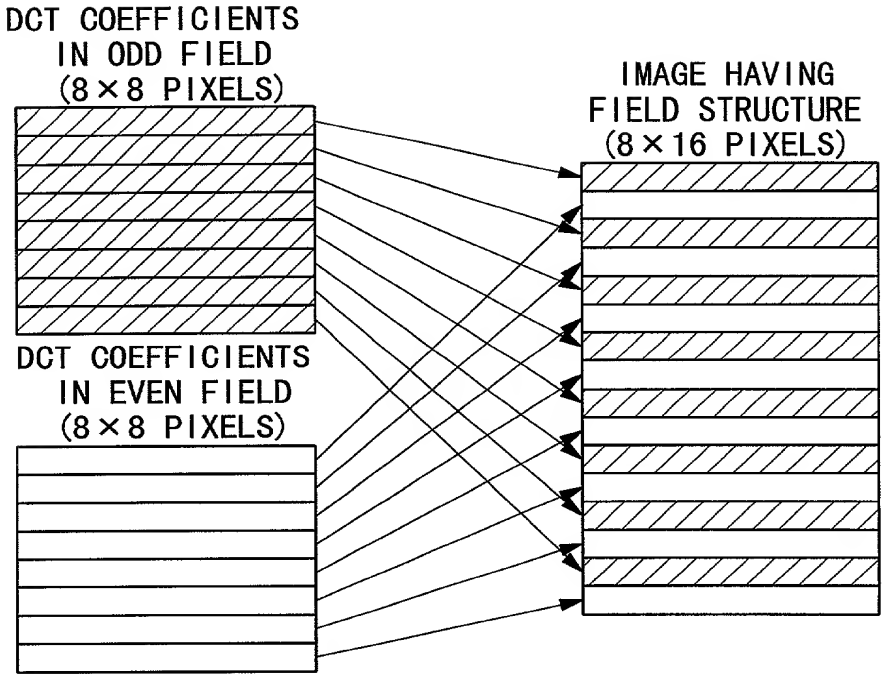

DCT COEFFICIENTS
IN ODD FIELD
(8×8 PIXELS)
DCT COEFFICIENTS
IN EVEN FIELD
(8×8 PIXELS)
IMAGE HAVING
FIELD STRUCTURE
(8×16 PIXELS)

FIG. 3

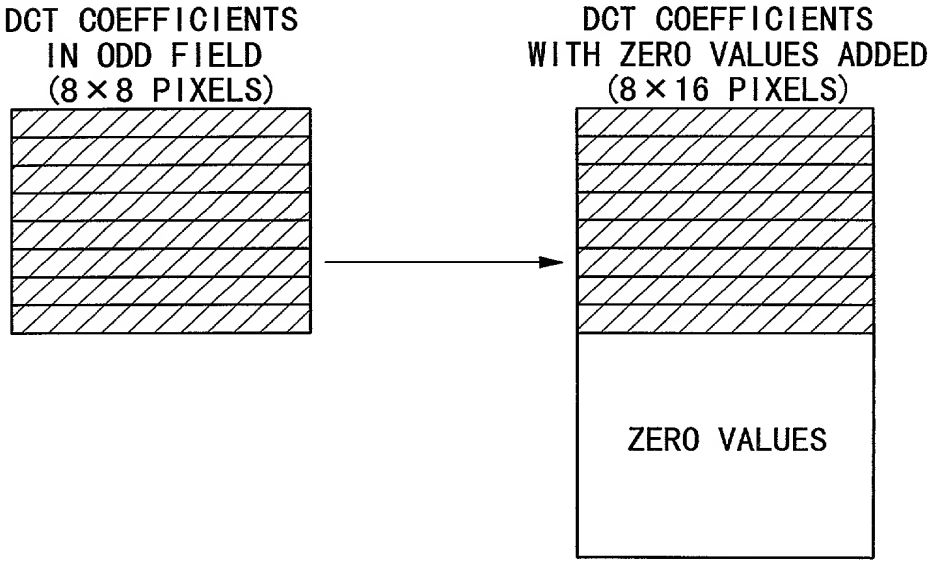

DCT COEFFICIENTS
IN ODD FIELD
(8×8 PIXELS)
DCT COEFFICIENTS
WITH ZERO VALUES ADDED
(8×16 PIXELS)
ZERO VALUES

FIG. 4

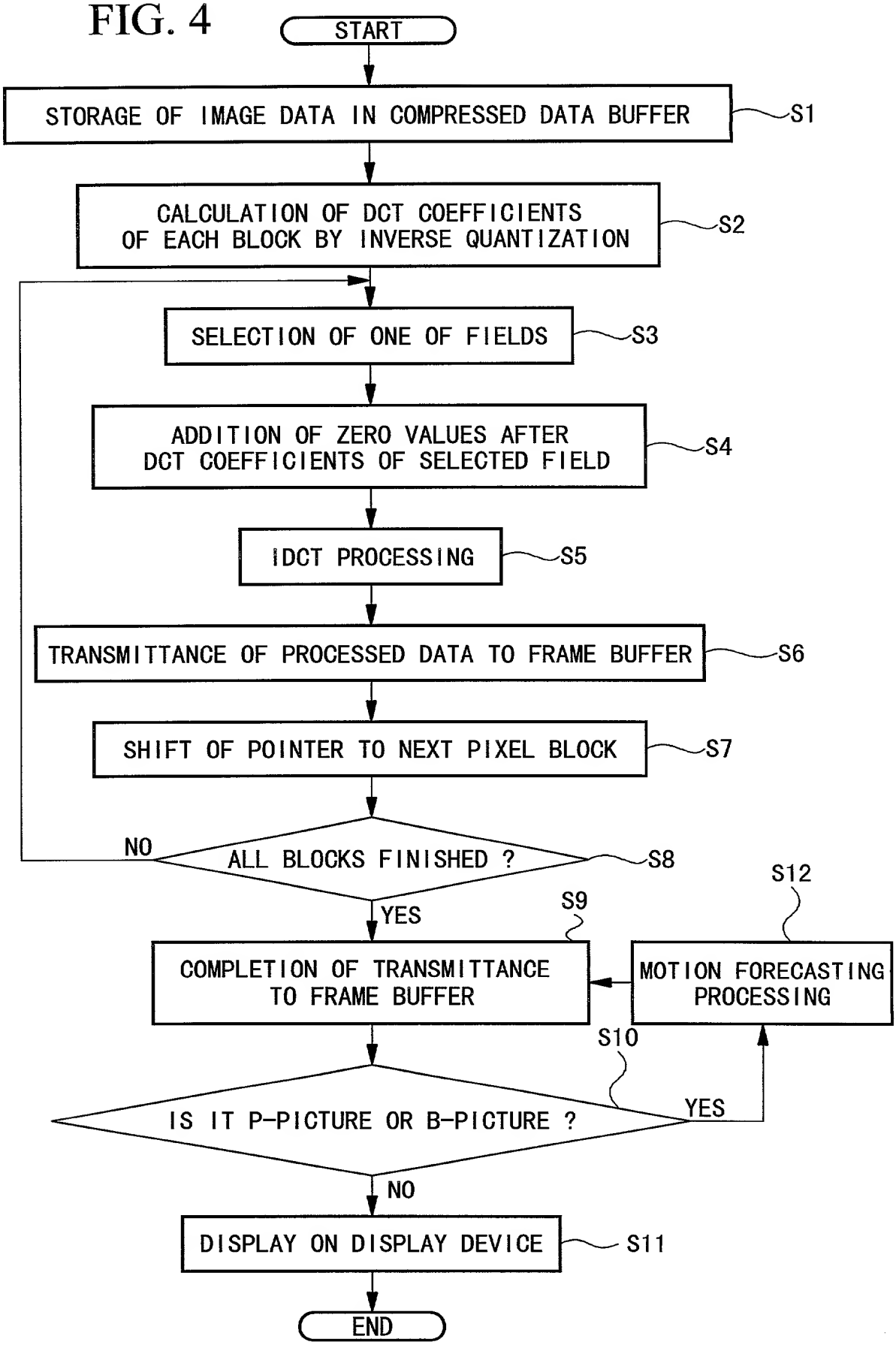

START
STORAGE OF IMAGE DATA IN COMPRESSED DATA BUFFER
S1
CALCULATION OF DCT COEFFICIENTS OF EACH BLOCK BY INVERSE QUANTIZATION
S2
SELECTION OF ONE OF FIELDS
S3
ADDITION OF ZERO VALUES AFTER DCT COEFFICIENTS OF SELECTED FIELD
S4
IDCT PROCESSING
S5
TRANSMITTANCE OF PROCESSED DATA TO FRAME BUFFER
S6
SHIFT OF POINTER TO NEXT PIXEL BLOCK
S7
NO
ALL BLOCKS FINISHED ?
S8
YES
S9
COMPLETION OF TRANSMITTANCE TO FRAME BUFFER
S12
MOTION FORECASTING PROCESSING
S10
IS IT P-PICTURE OR B-PICTURE ?
YES
NO
DISPLAY ON DISPLAY DEVICE
S11
END

FIG. 5

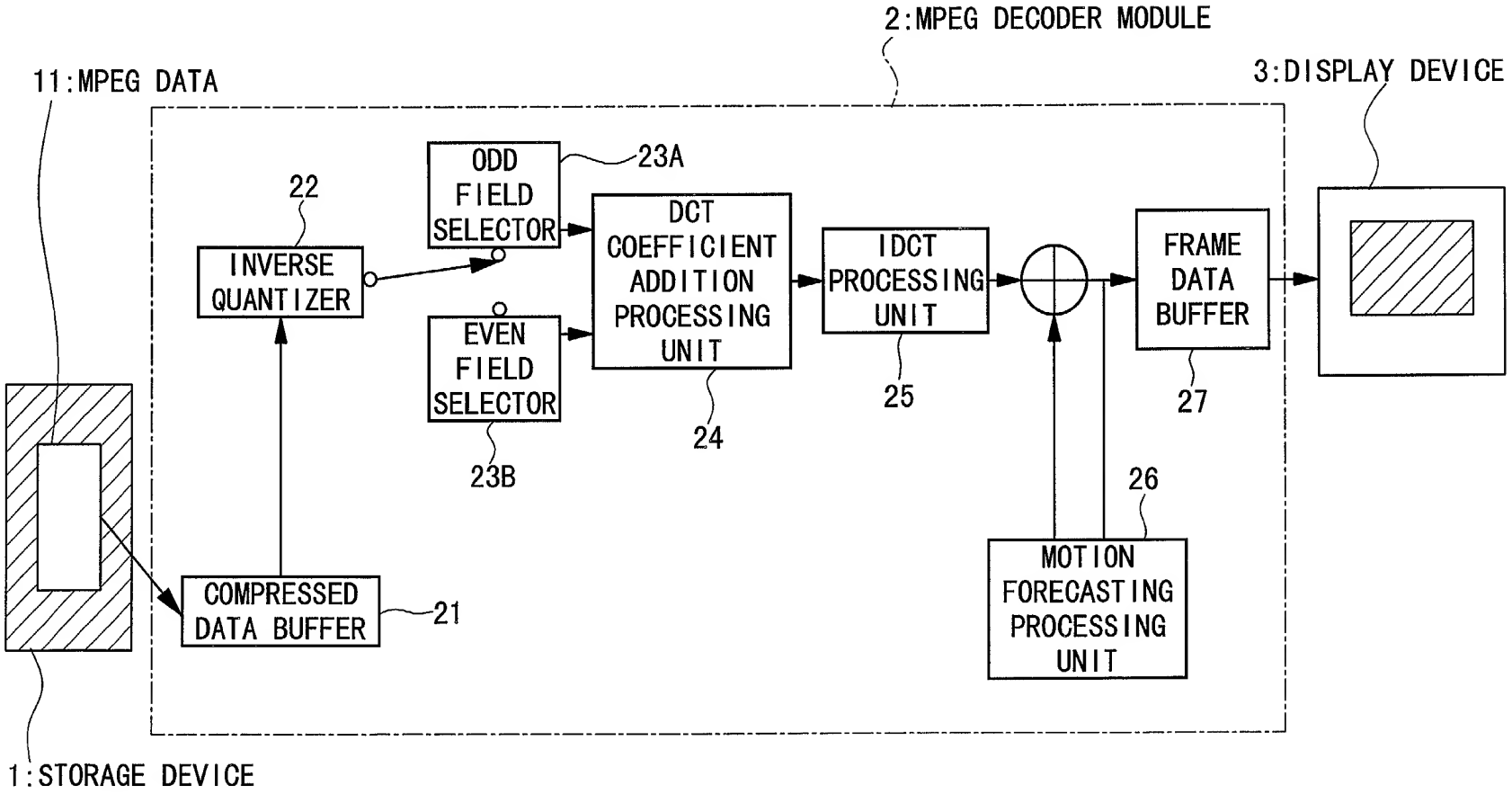
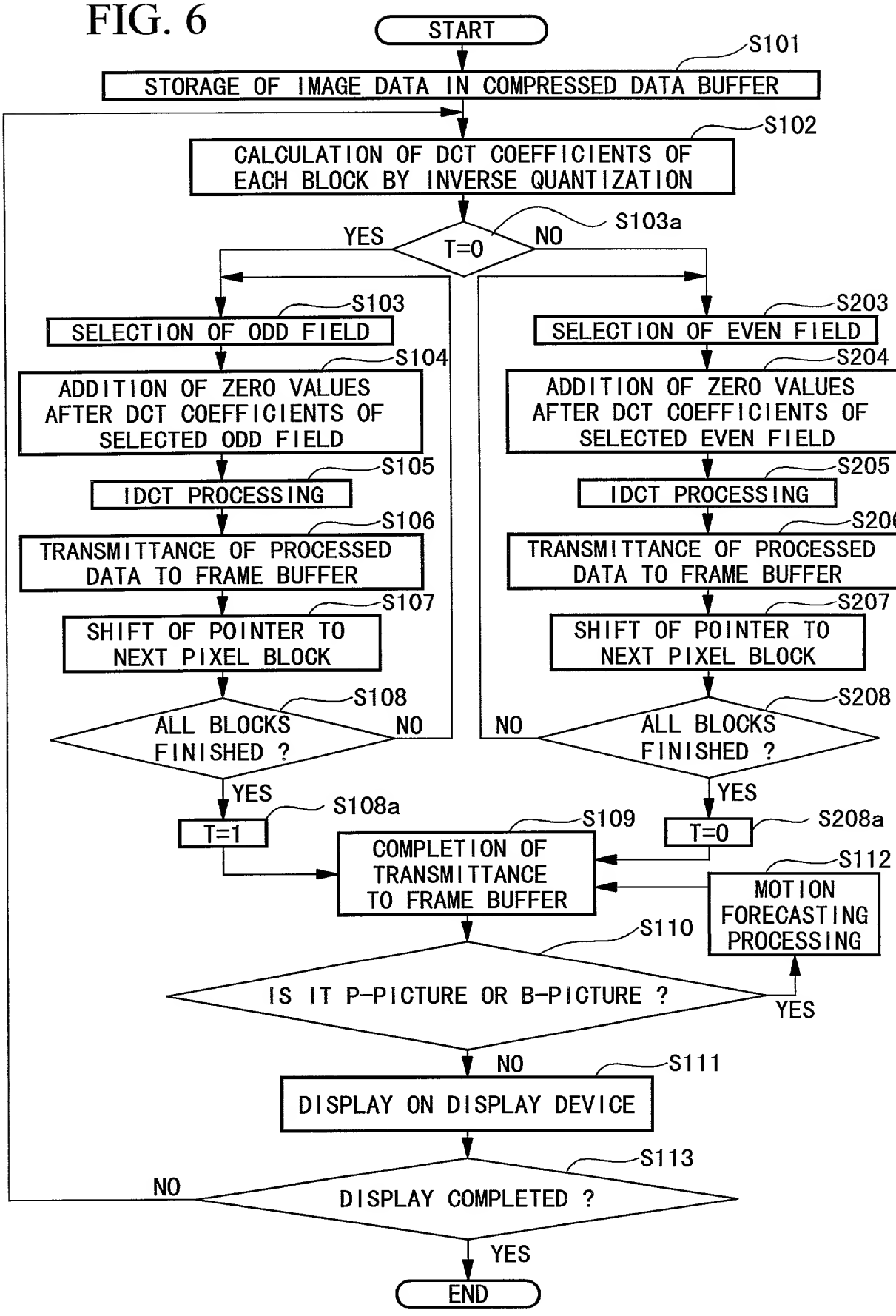

2:MPEG DECODER MODULE
11:MPEG DATA
3:DISPLAY DEVICE
ODD FIELD SELECTOR
23A
22
INVERSE QUANTIZER
DCT COEFFICIENT ADDITION PROCESSING UNIT
IDCT PROCESSING UNIT
FRAME DATA BUFFER
EVEN FIELD SELECTOR
23B
24
25
27
26
MOTION FORECASTING PROCESSING UNIT
COMPRESSED DATA BUFFER
21
1:STORAGE DEVICE

FIG. 6


START
S101
STORAGE OF IMAGE DATA IN COMPRESSED DATA BUFFER
S102
CALCULATION OF DCT COEFFICIENTS OF EACH BLOCK BY INVERSE QUANTIZATION
S103a
T=0
YES
NO
S103
SELECTION OF ODD FIELD
S104
ADDITION OF ZERO VALUES AFTER DCT COEFFICIENTS OF SELECTED ODD FIELD
S105
IDCT PROCESSING
S106
TRANSMITTANCE OF PROCESSED DATA TO FRAME BUFFER
S107
SHIFT OF POINTER TO NEXT PIXEL BLOCK
S108
ALL BLOCKS FINISHED ?
NO
YES
S108a
T=1
S203
SELECTION OF EVEN FIELD
S204
ADDITION OF ZERO VALUES AFTER DCT COEFFICIENTS OF SELECTED EVEN FIELD
S205
IDCT PROCESSING
S206
TRANSMITTANCE OF PROCESSED DATA TO FRAME BUFFER
S207
SHIFT OF POINTER TO NEXT PIXEL BLOCK
S208
ALL BLOCKS FINISHED ?
NO
YES
S208a
T=0
S109
COMPLETION OF TRANSMITTANCE TO FRAME BUFFER
S112
MOTION FORECASTING PROCESSING
S110
IS IT P-PICTURE OR B-PICTURE ?
YES
NO
S111
DISPLAY ON DISPLAY DEVICE
S113
DISPLAY COMPLETED ?
NO
YES
END

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Docket No _____

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that.

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

FRAME DISPLAY METHOD AND APPARATUS USING SINGLE FIELD DATA

the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as United States Application Number or PCT International Application Number _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is known by me to be material to patentability as defined in Title 37, Code of Federal Regulations § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

NUMBER	COUNTRY	DAY/MONTH/YEAR FILED	PRIORITY CLAIMED
Patent 10-156406	Japan	04/06/1998	YES

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

APPLICATION NO.	FILING DATE

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is known by me to be material to patentability as defined in Title 37, Code of Federal Regulations § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

APPLICATION SERIAL NO.	FILING DATE	STATUS: PATENTED, PENDING, ABANDONED

I hereby appoint as my attorneys, with full powers of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Stephen A. Bent, Reg. No. 29,768; David A. Blumenthal, Reg. No. 26,257; John J Feldhaus, Reg. No. 28,822; Donald D. Jeffery, Reg. No. 19,980; Eugene M. Lee, Reg. No. 32,039; Peter G. Mack, Reg. No. 26,001; Brian J. McNamara, Reg. No. 32,789; Sybil Meloy, Reg. No. 22,749; George E. Quillin, Reg. No. 32,792; Colin G. Sandercock, Reg. No. 31,298; Bernhard D. Saxe, Reg. No. 28,665; Charles F. Schill, Reg. No. 27,590; Richard L. Schwaab, Reg. No. 25,479; Arthur Schwartz, Reg. No. 22,115; Harold C. Wegner, Reg. No. 25,258.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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DO NOT ENTER